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(54) IMPROVEMENTS IN OR RELATING TO
 THE PRODUCTION OF SECURITY DOCUMENTS

(71) We, THOMAS DE LA RUE & COMPANY LIMITED, a British Company of 84/86 Regent Street, London W1A 1DL do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

10 This invention relates to the production of security documents and especially to the production of security documents provided with markings whereby the genuineness of the document may be readily and easily ascertained.

15 Security documents such as, for example, identity cards, airline tickets, passports, banknotes, share certificates, bonds, lottery tickets or cheques are customarily printed, at least on certain areas, with inks which, in combination with other inks and/or the substrate, confer on the document desired security features. It is customary when producing security documents to employ a plurality of inks and/or printings and for the genuineness of the documents produced to be ascertained by close examination of the inks and printing; however, such close examination requires considerable time to perform and, usually the services of an expert.

During the lifetime of a security document it commonly changes hands or is inspected several times and the majority of those into whose possession it passes are not expert in determining the genuineness of the document. It is consequently desirable that security documents should possess a feature such that their genuineness may be simply and quickly determined by those not skilled in the task.

Metamerism — which is defined by W. D. Wright in "The Measurement of colour", 4th Edition 1969 as "The phenomenon of identity of colour appearance between

stimuli of different spectral composition"—has hitherto been generally regarded as an undesirable phenomenon in colour science and steps are customarily taken to avoid or, at least reduce to an acceptable level, 50 the effect of this phenomenon. However, we have found that this phenomenon may be usefully employed in providing the security documents of our invention.

Because materials that a metameric have 55 different spectral compositions (i.e. different spectral reflectance curves) whilst they have identical colour appearances under one set of illuminating and/or viewing conditions they will lose this identity when any factor 60 affecting the observed colour is changed. The illuminant, the observer and the geometry of viewing conditions may all affect the colour observed and hence metamerism is customarily regarded as being of three 65 classes.

The first of these classes, and that in which the phenomenon is most commonly observed, is "illuminant" metamerism i.e. when two objects or areas appear to have 70 an identical colour appearance under a first illuminant but have differing appearances under a second illuminant having a colour substantially the same as, but a different spectral energy distribution from the first, 75 then the objects or areas are exhibiting "illuminant" metamerism.

The second class is known as "observer" metamerism and is exhibited when objects — being viewed under the same illuminant 80 — appear to be a colour match to one observer but to be a mis-match to another observer; this class of metamerism arises usually, from differences in density of the yellow macular pigment in the retinas of 85 the observers.

The third, "geometric" class of metamerism, arises out of the effect of parameters such as field size, angle of illumination angle of viewing and texture of the 90

surface; for example, due to the non-uniform structure of the retina, objects which appear to match when their image falls on the fovea may be observed as a mismatch when the image is observed extra-foveally and vice versa.

Although there are, as stated above, three classes of "metamerism" we shall hereinafter mean by "metamerism", "illuminant" metamerism.

Where hereinafter we use the term "ink" we mean those coloured compositions of fluid, pasty or waxy consistency employed in writing, printing, typing, stamping or transfer techniques whereby coloured markings are made upon a receptive surface.

Where we use the term "markings" we mean visible coloured marks made upon the document by known techniques such as printing, writing, typing, stamping, transfer processes or any combination of same.

Where herein we use the term "pair of metameric inks" we mean a pair of inks, each comprised only of materials which are not transformed by radiation to an excited form having a different colour to the un-excited form, wherein each of said inks has a different spectral composition (i.e. different spectral absorption and/or reflectance curve), from the other and said pair being such that when viewed under a first illuminant, having a first spectral energy distribution they are substantially identical to each other in colour appearance but when viewed under a second illuminant, having substantially the same colour as but a different spectral energy distribution to the first, they are substantially different from each other in colour appearance.

According to our invention a novel security document comprises a substrate having markings thereon in each of at least one pair of metameric inks (as defined herein).

When the colour difference between a pair of metameric inks when viewed under the second illuminant is very marked then there is said to be a high degree of metamerism between the inks, whilst a low degree of metamerism is said to exist when the colour difference is small. It is a feature of our invention that we use this characteristic of the metameric inks employed to enable the genuineness of the documents bearing markings in such inks to be conveniently demonstrated. We prefer, in order that this demonstration be facilitated, to employ pairs of inks exhibiting a high degree of metamerism.

Clearly in order for any pair of inks to exhibit metamerism it is only necessary that one of the pair exhibits a different colour appearance when viewed under illuminants of substantially the same colour but of differing spectral energy distributions. That is,

whilst both inks forming a metameric pair may exhibit illuminant dependent colour inconstancy it is only essential that one of the pair does so.

When preparing our novel security documents each of the metameric inks employed may exhibit colour inconstancy if desired, but optionally, one of each pair of metameric inks is substantially colour constant.

The documents of our invention may be provided with markings in metameric inks by any technique known for making ink markings such as, for example, by printing, writing, typing, stamping or transfer techniques or any combinations of the same. Thus, for example, the markings may be applied to the substrate by means of a writing implement by intaglio, lithographic or letterpress printing techniques alone, or, one or more of the inks may be applied to a carrier body, or transfer sheet from whence it is transferred to the required position on the substrate by any suitable and appropriate means comprising, for example, a typewriter or rubber stamp.

When applied by printing means some of the markings in metameric inks may suitably form part of all of the background design commonly provided on security documents.

If markings are to be made with a pair of metameric inks whereby one of the pair is to be applied by a printing technique, and the other by a transfer technique then suitably that ink applied by printing is a colour constant ink and preferably a conventional colour constant ink. (The term "colour constant" means that when the material (ink) is viewed under different illuminants, having substantially the same colour but differing spectral energy distribution, the colour observed is substantially the same). However, due to difficulties in preparing pairs of metameric inks having the different physical properties necessary for their satisfactory transfer and performance as printing and "transfer" inks respectively, this technique is not preferred.

When transfer methods are used to provide the markings in one or more metameric inks, the transfer sheet or web may be of the "partial" or "total" transfer type. The "partial" transfer type is exemplified by a conventional fabric typewriter ribbon which is commonly used repeatedly because part only of the ink is transferred from any particular area corresponding to the size and shape of the pressure applying means in each use. By a "total" transfer sheet we mean that type of transfer sheet or web that is customarily used once only as, in use, a substantially total transfer, of that area of the ink layer corresponding in size and shape to the pressure applying means, oc-

curs from the sheet to the receptive substrate.

The transfer sheet may be provided with at least a pair of metameric inks in complementary areas or, optionally, with a transfer layer of an ink metameric with an ink provided, or to be provided, on the document by printing, typing, or by means of a further transfer sheet.

- 10 If the documents are to be provided with markings in both inks of a metameric pair, by typewriter, it is preferred that the typewriter ribbon is similar in construction to the conventional dual ink ribbon but instead of being provided with red and black inks it is provided with a pair of metameric inks; more preferably, the ribbon employed is of the "total" transfer type. Suitably, markings in each of the metameric inks are then applied to the document by typing the desired legend or number with variation between the alternate ribbon positions as required.

When the security documents of our invention are to be provided with markings in metameric inks by means of transfer sheets or ribbons co-operating with pressure operable indicia applying means of the kind wherein the markings are made a line at a time, rather than an individual indicia at a time, then the transfer sheet or ribbon is suitably provided, with the metameric inks in complementary adjacent longitudinal parallel stripes.

- 35 When documents are marked through the co-operation of such transfer means then all the indicia in any columnar array will be provided in one of the inks and adjacent thereto will be a columnar array of indicia formed in the other ink of the metameric pair. Hence, whilst under one illuminant the indicia thus applied will appear to be all of one colour, under a suitably different illuminant the indicia will be seen to be arranged in columns, the colour of any such column being different from those immediately on either side of it. Optionally, if desired, such sheets or ribbons may be provided with longitudinal stripes in three or more metameric inks, security of the documents increasing with the number of metameric inks due to difficulties in compounding pluralities of inks to be good metamers. Preferably such sheets or ribbons are of the "total" transfer type.

Irrespective of the means employed for providing the substrate with markings in metameric inks, we prefer that at least some of the markings made in one of the inks comprising a metameric pair are closely adjacent to at least some of the markings made in the other ink comprising said pair.

The metameric inks used to prepare the security documents of our invention should be chosen so that they exhibit their colour

match under illuminants customarily employed in their inspection. We prefer that the inks be such that they substantially match in colour under "daylight viewing conditions" such viewing conditions being provided by natural lighting or by artificial lighting designed to approximate to natural daylight. With such inks of the preferred type, evidence of their metamerism and hence evidence of the genuineness of the document printed therewith, may be provided simply and easily by inspecting the document under an illuminant having a different spectral energy distribution from but substantially the same colour as that of the customarily employed illuminant. Thus, for example, if the document is prepared using inks compounded so as to exhibit a colour match under "daylight viewing" conditions, then the metamerism of the inks employed may be demonstrated by viewing successively under "daylight" illumination and under an illuminant having a greater proportion of its spectral energy in the red end of the spectrum; such an illumination being conveniently provided, for example, by a tungsten filament lamp.

Obviously if the security document is one that is normally inspected under tungsten illumination, then the inks employed should substantially colour match when viewed under this illuminant and their metamerism may be suitably demonstrated by viewing them, for example, first under tungsten illumination and then under an illuminant having substantially the same colour but with a greater proportion of its spectral energy in the blue end of the spectrum; such illumination being provided, for example, by a "daylight" type fluorescent lamp.

The substrate employed in the production of the security documents may be any known for such use including, for example, woven fabrics, cardboard and plastics; we prefer, however, to employ a paper substrate, and such may be of the type known generally as "safety paper" having incorporated therein or thereon watermarks, metal strips, planchettes, chemicals and/or other materials or any combination thereof, added so as make unauthorised reproduction of the document more difficult. Preferably the documents of our invention also bear printed markings in conventional inks, such conventional inks suitably comprising "safety" inks of permanent and/or fugitive types known for preparing security documents. Such optional printings may be applied before, during or after application to the substrate of the metameric ink markings. If desired markings in conventional inks may be so made and/or positioned as to be closely adjacent to markings in meta-

meric inks on the substrate, or markings in conventional inks may be so arranged as to facilitate subsequent application to the document of metamer ink markings closely adjacent thereto. We prefer that when the substrate of our invention is provided with markings in conventional inks that these inks possess a high degree of colour constancy, thus serving to emphasise the change in appearance of the colour inconstant ink used to form at least one of each pair of metamer ink markings on the documents of our invention. If desired, one of the inks comprising a pair of metamer inks may comprise a conventional ink.

It is within the scope of our invention to employ more than one pair of metamer inks and if desired a plurality of pairs of such inks may be employed. The employment of such a plurality of pairs may serve not only to enhance the security of the document but also to facilitate a rapid demonstration of its genuineness.

When more than two metamer inks are employed (three metamer inks give rise to three pairs of inks) we prefer that the spectral reflection curves of the inks are such that whilst they are all substantially identical under one illuminant, there is no colour match between any of the inks when viewed under an illuminant having substantially the same colour but different spectral energy characteristics.

The following Examples serve to illustrate further our invention.

EXAMPLE 1

A pair of metamer green inks colour matching under daylight illumination were prepared as follows:—

Ink "A"

This ink is a green colour constant ink and is of similar characteristics and composition to conventionally known normal offset or letterpress inks. It was prepared by standard ink making techniques and had the following composition:—

	% by weight
50 Pigment yellow	10.4
Monolite Orange "C+"	0.6
Naphthol green	34.2
Offset in vehicle (drying oil modified alkyd)	49.8
55 Aliphatic hydrocarbon solvent (Boiling range 260-290°C)	5.0
	100.00

60 Ink "B"

This ink is colour inconstant and was prepared by techniques used for preparing water based inks for application by letterpress or dry-offset methods. The ink had the following composition:—

	% by weight
Paper yellow 5GL	19.5
Benzyl violet 5BN	0.5
Water based vehicle (comprising dextrin in glycerol)	33.0
Glycerol	47.0
	100.00

A lottery ticket bearing printed indicia and background markings in both permanent and fugitive colour constant inks was provided with a serial number comprising in line and in order three letters, six figures and a further three letters. The letters were provided by letter press printing using ink "A" whilst the numbers were provided, again by letter press using ink "B".

When viewed under "daylight" Fluorescent illumination the letters and figures presented a colour-matching appearance, whilst when viewed under a tungsten filament lamp the letters and figures mis-matched markedly.

EXAMPLE 2

An ink-filled "partial" transfer typewriter ribbon was prepared in a conventional manner, so that the tape was provided in two longitudinal complementary stripes with the inks "C" and "D" below.

Ink "C"

This ink, having a water based vehicle, was prepared in a conventional manner and had the following composition:—

	% by weight
Lissamine green V500	2.0
Naphthalene scarlet	3.5
Water based vehicle (comprising dextrin in glycerol)	45.0
Glycerol	49.5
	100.00

Ink "D"

This ink again had a water based vehicle and was prepared in a conventional manner. It had the following composition:—

	% by weight
Benzyl violet 5BN	2.6
Tartrazine yellow (N200)	2.0
Water based vehicle (as in ink "C")	41.4
Glycerol	54.0
	100.00

The ink filled ribbon prepared from these two inks had a uniform black appearance in daylight illumination. Security documents (for example, share certificates) were made out using the ribbon, prepared as

above, as follows:—

The ribbon of a conventional typewriter was replaced by the ribbon prepared as above and a share certificate, having printed 5 markings thereon in "safety" inks was then made out employing this ribbon so that by suitable operation of the ribbon shift key, markings were made on the certificate in both ink "C" and ink "D". (In this particular 10 case alternate words were typed in the two inks, but our invention is not so limited). When viewed under natural daylight the document appeared to be made out in a single grey-black coloured ink but 15 when viewed under a tungsten filament lamp the markings which had appeared to be a uniform grey-black now appeared as alternating markings in a red tinted ink and a green tinted ink. This change in appearance 20 of the markings under the two different illuminants was most pronounced and enabled the document to be rapidly differentiated from a similar document produced by means of a typewriter ribbon carrying conventional inks. 25

WHAT WE CLAIM IS:—

1. A security document comprising a substrate having markings (as defined herein) thereon in each of at least one pair of 30 metamerik inks (as herein defined).

2. A security document as claimed in claim 1 wherein one of the inks comprising any pair of metamerik inks is substantially colour constant (as defined herein).

3. A security document as claimed in claim 1 wherein neither of the inks comprising any pair of metamerik inks is substantially colour constant.

4. A security document as claimed in any preceding claim wherein at least some of the markings made in one of the inks comprising a metamerik pair are closely adjacent to at least some of the markings made in the other ink comprising said pair.

5. A security document as claimed in any preceding claim wherein markings in at least one of said pair of metamerik inks have been provided by intaglio, lithographic or letter press printing means.

6. A security document as claimed in any one of claims 1 to 4 wherein markings in at least one of said pair of metamerik inks have been impressed from a transfer sheet or web, bearing said at least one of 55 said pair of metamerik inks.

7. A security document as claimed in any one of claims 1 to 4 wherein said markings in each of a pair of metamerik inks have been impressed from a transfer sheet or web bearing said pair of metamerik inks. 60

8. A security document as claimed in claim 6 or claim 7 wherein the transfer sheet or web is a total transfer sheet or web (as herein defined).

9. A security document as claimed in any preceding claim having other markings thereon said other markings being in conventional inks and provided by a printing process.

10. A security document as claimed in any preceding claim wherein the substrate comprises a woven fabric, cardboard or a plastics material. 70

11. A security document as claimed in any one of claims 1 to 9 wherein the substrate comprises paper. 75

12. A security document as claimed in claim 11 wherein the substrate comprises safety paper (as herein defined).

13. A process for preparing a security document according to claim 1 comprising providing on a substrate markings in each of at least one pair of metamerik inks.

14. A process for preparing a security document as claimed in claim 13 whereby 85 said markings are provided by printing means.

15. A process for preparing a security document as claimed in claim 14 wherein neither of the inks comprising any pair of 90 metamerik inks is substantially colour constant.

16. A process for preparing a security document as claimed in claim 13 wherein a substrate is provided with printed markings in a conventional ink or inks and also provided with markings in each of at least one pair of metamerik inks by impressing said markings from a transfer sheet or web bearing said at least one pair of metamerik 100 inks.

17. A process for preparing a security document according to claim 1 substantially as described in any of the Examples.

18. A security document as claimed in claim 1 when prepared by a process as 105 claimed in any one claims 13 to 17.

(W. W. WYNDHAM) SECRETARY.
THOMAS DE LA RUE AND CO. LTD.